What is Claimed is:

1. A method for determining the temperature distribution throughout the thickness of a preform used in a container reheat stretch blow molding process, comprising:

    measuring the outside surface temperature of the preform at least two times during the period the preform is cooling down after exiting the heat station and before entering the blow molding station; and

    calculating the temperature distribution throughout the thickness of the preform based upon the measured outside surface temperatures using an algorithm comprising:

    curve fitting the measured outside surface temperatures to solve for A_n using an equation having the formula

$$T(0,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n{}^2 \alpha t} (z_n k / h)$$

    and using the A_n values to calculate the through-the-thickness temperature distribution for the preform using an equation having the formula

$$T(x,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n{}^2 \alpha t} v_n(x),$$

    where T(x,t) is the through-the-thickness temperature distribution of the present invention, T(0,t) is the outside temperature as a function of time t which is curvefit to the experimental data to determine the unknown front factors A_n, Tc is the ambient air temperature, e is the exponential equal to 2.718, v_n are the eigenvectors for the nth eigenvalue z_n, k is conductivity, x is the depth of the preform from the outside surface, and α is the thermal diffusivity.

2. The method of Claim 1 wherein the temperature distribution throughout the thickness of the preform is calculated using a computer programmed to compute the temperature distribution using the algorithm.

3. The method of Claim 1 wherein the preform comprises a polymer selected from the group consisting of polyester, copolyester, nylon, polycarbonate, acrylonitrile, polyvinyl chloride, polyolefins, ethylene-vinyl alcohol, styrenics, and combinations thereof.

4. The method of Claim 1 wherein the preform is selected from the group consisting of polyester preforms and copolyester preforms.

5. A preform having a temperature distribution optimized for the production of high quality containers based upon the temperature distribution calculated using the method of Claim 1.

6. The preform of Claim 5 comprising a polymer selected from the group consisting of polyester, copolyester, nylon, polycarbonate, acrylonitrile, polyvinyl chloride, polyolefins, ethylene-vinyl alcohol, styrenics, and combinations thereof.

7. The preform of Claim 5 selected from the group consisting of polyester preforms and copolyester preforms.

8. A device for determining the temperature distribution throughout the thickness of a preform used in a container reheat stretch blow molding process from temperature measurements taken from the outside surface of the preform, comprising:

   a temperature measuring means for measuring the outside surface temperature of the preform at least two times during the period the preform is cooling down after exiting the heat station and before entering the blow molding station, wherein the temperature measuring means is coupled to a calculating means capable or receiving temperature data from the temperature measuring means; and

   a calculating means for calculating the temperature distribution throughout the thickness of the preform based upon the measured outside surface temperatures, wherein the calculating means receives outside surface temperature data from the temperature measuring means and calculates the preform temperature distribution using an algorithm comprising:

   curve fitting the measured outside surface temperatures to solve for A_n using an equation having the formula

$$T(0,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n^2 \alpha t} (z_n k / h)$$

   and using the A_n values to calculate the through-the-thickness temperature distribution for the preform using an equation having the formula

$$T(x,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n^2 \alpha t} v_n(x),$$

   where T(x,t) is the through-the-thickness temperature distribution of the present invention, T(0,t) is the outside temperature as a function of time t which is

curvefit to the experimental data to determine the unknown front factors A_n, Tc is the ambient air temperature, e is the exponential equal to 2.718, v_n are the eigenvectors for the nth eigenvalue z_n, k is conductivity, x is the depth of the preform from the outside surface, and α is the thermal diffusivity.

9. The device of Claim 8 wherein the temperature measuring means is selected from the group consisting of pyrometers, thermocouples, and infrared cameras.

10. The device of Claim 8 wherein the temperature measuring means is one or more infrared cameras.

11. The device of Claim 8 wherein the temperature measuring means is a pyrometer array.

12. The device of Claim 8 wherein the calculating means is a computer programmed to compute the temperature distribution using the algorithm.

13. The device of Claim 8 further comprising a displaying means for communicating the calculated temperature distribution in a human readable format.

14. A method for manufacturing high quality containers using a reheat stretch blow molding process, comprising:

determining the temperature distribution throughout the thickness of a preform used to manufacture containers using a method comprising:

measuring the outside surface temperature of the preform at least two times during the period the preform is cooling down after exiting the heat station and before entering the blow molding station in the blow molding machine;

calculating the temperature distribution throughout the thickness of the preform based upon the measured outside surface temperatures using an algorithm comprising:

curve fitting the measured outside surface temperatures to solve for A_n using an equation having the formula

$$T(0,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n{}^2 \alpha t}(z_n k / h)$$

and using the A_n values to calculate the through-the-thickness temperature distribution for the preform using an equation having the formula

$$T(x,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n{}^2 \alpha t} v_n(x),$$

where $T(x,t)$ is the through-the-thickness temperature distribution of the present invention, $T(0,t)$ is the outside temperature as a function of time t which is curvefit to the experimental data to determine the unknown front factors A_n, Tc is the ambient air temperature, e is the exponential equal to 2.718, v_n are the eigenvectors for the nth eigenvalue z_n, k is conductivity, x is the depth of the preform from the outside surface, and α is the thermal diffusivity;

using the calculated temperature distribution to adjust the heating elements used to heat preforms in the heat station to obtain a desired preform temperature distribution; and

blow molding the preforms into containers.

15. A container made according to the method of Claim 14.
16. The container of Claim 14 comprising a polymer selected from the group consisting of polyester, copolyester, nylon, polycarbonate, acrylonitrile, polyvinyl chloride, polyolefins, ethylene-vinyl alcohol, styrenics, and combinations thereof.
17. The container of Claim 14 selected from the group consisting of polyester containers and copolyester containers.
18. A reheat stretch blow molding machine, comprising:

a heat station where preforms are heated;

a blow molding station where the preforms are converted to containers;

a means for transporting heated preforms from the heat station to the blow molding station at an essentially uniform rate;

a temperature measuring means for measuring the outside surface temperature of a preform at least two times during the period the preform is cooling down after exiting the heat station and before entering the blow molding station, wherein the temperature measuring means is coupled to a calculating means capable or receiving temperature data from the temperature measuring means; and

a calculating means for calculating the temperature distribution throughout the thickness of the preform based upon the measured outside surface temperatures, wherein the calculating means receives outside surface temperature data from the temperature measuring means and calculates the preform temperature distribution using an algorithm comprising:

curve fitting the measured outside surface temperatures to solve for A_n using an equation having the formula

$$T(0,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n^2 \alpha t} (z_n k / h)$$

and using the A_n values to calculate the through-the-thickness temperature distribution for the preform using an equation having the formula

$$T(x,t) = Tc + \sum_{n=1}^{\infty} A_n e^{-z_n^2 \alpha t} v_n(x) ,$$

where T(x,t) is the through-the-thickness temperature distribution of the present invention, T(0,t) is the outside temperature as a function of time t which is curvefit to the experimental data to determine the unknown front factors A_n, Tc is the ambient air temperature, e is the exponential equal to 2.718, v_n are the eigenvectors for the nth eigenvalue z_n, k is conductivity, x is the depth of the preform from the outside surface, and α is the thermal diffusivity, and

wherein the calculating means is coupled to the heat station such that the calculating means can adjust the heat station heating elements based upon the calculated preform temperature distribution and control the temperature distribution throughout the thickness of a preform in the heat station.

19. The machine of Claim 18 wherein the temperature measuring means is selected from the group consisting of pyrometers, thermocouples, infrared cameras, and infrared linescanning cameras.
20. The machine of Claim 18 wherein the temperature measuring means is one or more infrared cameras.
21. The machine of Claim 18 wherein the temperature measuring means is a pyrometer array.
22. The machine of Claim 18 wherein the calculating means is a computer programmed to compute the temperature distribution using the algorithm.
23. The machine of Claim 18 further comprising a displaying means for communicating the calculated temperature distribution in a human readable format.